

Applicant: Frank T. Hartley
Serial No.: 10/786,230
Filed: Feb. 26, 2004
Page: 3 of 15

Amendments to the Claims:

This listing of claims replaces all prior versions and listings of claims in the application:

Listing of Claims

1. (Currently Amended) An apparatus for use with an ion thrusting system, the apparatus comprising: an ionization membrane having at least one area through which a gas is passed, and which ionizes the gas molecules passing therethrough to form ions and electrons; and an accelerator element which accelerates

~~the ions to form thrust, wherein said ionization membrane~~
comprises: an insulating element having at least one opening, a first conductive electrode extending on a first surface of said insulating element at the at least one opening and a second conductive electrode extending on a second surface of the insulating element at the at least one opening, wherein said insulating element separates said first and second conductive electrodes at said at least one opening by a thickness less than the mean free path of the molecules within the gas being ionized.

Applicant: Frank T. Hartley
Serial No.: 10/786,230
Filed: Feb. 26, 2004
Page: 4 of 15

2. (Previously Presented) The apparatus of claim 1 wherein the accelerator element is a cathode.

3-8. (Canceled).

9. (Previously Presented) The apparatus of claim 1 wherein the ionization membrane has one of said areas.

10. (Previously Presented) The apparatus of claim 1 wherein the ionization membrane has a plurality of said areas.

12. (Previously Presented) The apparatus of claim 11 wherein said first and second conductive electrodes are separated by less than 1 micron at the at least one opening.

13. (Previously Presented) The apparatus of claim 12 wherein said first and second conductive electrodes are separated by less than 300 nm at the at least one opening.

14. (Previously Presented) The apparatus of claim 13 wherein said first and second conductive electrodes are separated by

Applicant: Frank T. Hartley
Serial No.: 10/786,230
Filed: Feb. 26, 2004
Page: 5 of 15

less than 200 nm at the at least one opening.

15. (Previously Presented) The apparatus of claim 14 wherein said first and second conductive electrodes are separated by approximately 50 nm at the at least one opening.

16. (Previously Presented) The apparatus of claim 11 wherein the at least one opening tapers inwardly from the first surface of said insulating element to the second surface of said insulating element.

17. (Previously Presented) The apparatus of claim 11 further comprising a substrate disposed between said first and second conductive electrodes for providing structural support.

18. (Previously Presented) The apparatus of claim 11 wherein the at least one opening has a diameter approximately in the range of 2-3 microns.

19. (Previously Presented) The apparatus of claim 11 wherein said first and second electrodes are formed of at least one of gold, chrome or titanium.

Applicant: Frank T. Hartley
Serial No.: 10/786,230
Filed: Feb. 26, 2004
Page: 6 of 15

20. (Previously Presented) The apparatus of claim 11 wherein said insulating element is formed of silicon nitride or alumina.

21-32. (Canceled).

33. (Previously Presented) A method ~~of forming an apparatus for an ion thruster~~ comprising: forming a layer of thin dielectric material on a substrate that has a first specified thickness of a sufficient thickness to maintain structural integrity; forming a first electrode on the first surface of said thin dielectric material, said first electrode being formed of a metal material; forming at least one hole in said substrate; forming a second electrode on a second surface of the substrate including the at least one holes, such that at least a portion of the second electrode is on a second surface of the thin dielectric material; forming holes in the second electrode, thin dielectric material and the first electrode, which holes have side surfaces where the first and second electrodes are separated by a width of the thin dielectric material, wherein said thin dielectric material has a thickness which is less than the mean free path of the gas intended to be ionized; and generating ions to form

Applicant: Frank T. Hartley
Serial No.: 10/786,230
Filed: Feb. 26, 2004
Page: 7 of 15

~~thrust forming a tubular thruster member perpendicular to said substrate and enclosing at least one hole for directing expelled ions.~~

34. (Canceled).

35. (Original) The method claim 33 wherein the step of forming electrodes comprises depositing at least one of gold, chrome, or titanium.

36. (Original) The method of claim 33 wherein the step of forming a thin dielectric comprises depositing silicon nitride or alumina.

37. (Original) The method of claim 33 wherein said thin dielectric has a thickness less than 1 micron.

38. (Original) The method of claim 37 wherein said thin dielectric has a thickness less than 500 nm.

39. (Original) The method of claim 38 wherein said thin dielectric has a thickness less than 300 nm.

Applicant: Frank T. Hartley
Serial No.: 10/786,230
Filed: Feb. 26, 2004
Page: 8 of 15

40. The method of claim 39 wherein said thin dielectric has a thickness of approximately 50 nm.

41. The method of claim 37 further comprising the step of applying a voltage less than 15 volts between said first and second electrodes to form a field between said first and second electrodes in the range of tens to hundreds of megavolts per meter.

42. The method of claim 33 wherein said forming holes in said first and second electrode and said thin dielectric material comprises ion-beam milling.

43. The method of claim 33 wherein the holes formed in said first and second electrodes and said thin dielectric material are approximately 2-3 microns in diameter.

44. (Currently Amended) A method comprising the steps of:
providing an ionization device comprising an insulating element having at least one opening, a first conductive electrode extending on a first surface of said insulating element at the

Applicant: Frank T. Hartley
Serial No.: 10/786,230
Filed: Feb. 26, 2004
Page: 9 of 15

at least one opening and a second conductive electrode extending
on a second surface of the insulating element at the at least
one opening, wherein said insulating element separates said
first and second conductive electrodes at said at least one
opening by a thickness less than the mean free path of the
molecules within the gas being ionized ~~having first and second~~
~~ionizing electrodes spaced closer than the mean free path of~~
~~molecules to be ionized;~~ applying a potential across the first
and second electrodes to generate an ionization field to ionize
the molecules; and using ions generated by the ionization field
~~selectively diverting the ions~~ to generate thrust.

45-48. (Canceled).

49. (Previously Presented) An apparatus for use with an ion
thrusting system, the apparatus comprising: ionization means
for ionizing gas molecules passing therethrough to form ions and
~~having ionization electrodes spaced closer than a mean free path~~
~~of a gas molecule being ionized;~~ and accelerator means for
accelerating the ions to form thrust, wherein the ionization
means comprises: an insulating element having at least one
opening, a first conductive electrode extending on a first

Applicant: Frank T. Hartley
Serial No.: 10/786,230
Filed: Feb. 26, 2004
Page: 10 of 15

surface of said insulating element at the at least one opening
and a second conductive electrode extending on a second surface
of the insulating element at the at least one opening, wherein
said insulating element separates said first and second
conductive electrodes at said at least one opening by a
thickness less than the mean free path of the molecules within
the gas being ionized.

50. (New) An apparatus comprising:

a thick supporting portion with at least one opening formed
in the thick supporting portion;

an insulating element coated on a surface of the thick
supporting portion configured to form a hole within each at
least one opening in the thick supporting portion;

first and second metal electrodes coated on surfaces of the
thick supporting portion extending into the openings in the
thick supporting portion, where the insulating element separates
the first and second metal electrodes within the holes of the
insulating element by a distance less than the mean free path of
a material being ionized; and

means for generating thrust.

Applicant: Frank T. Hartley
Serial No.: 10/786,230
Filed: Feb. 26, 2004
Page: 11 of 15